IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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In re Application of:ALASTALO et al.

FILING DATE: Herewith ART UNIT:

TITLE: A METHOD FOR ARRANGING COMMUNICATION BETWEEN TERMINALS AND AN ACCESS POINT IN A COMMUNICATION SYSTEM

ATTORNEY DOCKET NO.: 460-010309-US(PAR)

The Commissioner of Patents and Trademarks
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Dear Sir.

Please amend the above-identified, enclosed patent application as follows:

IN THE CLAIMS

Please amend Claims 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 15, 16, 17, 19, 20, 21, 22, 23, 24, 27, 30, 31, 32, 33, 35, 40, 42, 43, 44, 46 and 47 as rewritten below:

3. The method according to claim 1, **characterized** in that in the data transmission frames (FR), also a random access phase (RA) is used, during which the terminal (MT1–MT4) can perform transmissions to the access point (AP1, AP2), that signals transmitted in said random access phase (RA) are stored at the access point, and that the stored signals are used to determine the spatial signature of the terminal (MT1–MT4)

4. The method according to claim 1, **characterized** in that the stored signals are used to determine time and frequency offsets of the terminal (MT1–MT4).

5. The method according to claim 1, **characterized** in that said measurements are used to determine the position of the terminal (MT1–MT4).

6. The method according to claim 1, **characterized** in that in data transmission from the terminal (MT1–MT4) to the access point (AP1, AP2), at least the following steps are taken:

— a receiving step, in which signals transmitted by a terminal are received with at least two different antennas,

— a first correction step, in which the received signals are corrected on the basis of the measured time and frequency offsets,

— a first conversion step, in which the corrected signals are subjected to time-to-frequency conversion,

— a first channel estimation step, in which the signals converted to the frequency domain are subjected to channel estimation and determination of the spatial signature,

— a combination step, in which the signals are combined, and

— a decoding step for decoding the combined signal to determine the information transmitted from the terminal (MT1–MT4).

8. The method according to claim 6, **characterized** in that at least said first conversion step is taken substantially simultaneously for signals relating to different terminals.

9. The method according to claim 6, **characterized** in that at least said first conversion step is taken consecutively for signals relating to different terminals.

10 The method according to claim 6, **characterized** in that after the combination step, also a second channel estimation and correction step is taken, in which properties of the communication channel are estimated on the basis of the combined signal, and the combined signal is corrected on the basis of the estimated properties of the communication channel.

11. The method according to claim 6, **characterized** in that said combination step is taken after said second channel estimation and correction step.

12 The method according to claim 6, **characterized** in that signals transmitted by at least two different terminals are received at the access point substantially simultaneously, wherein said first correction step, first conversion step, combination step and decoding step are taken separately for the signal of each terminal.

13 The method according to claim 6, **characterized** in that in data transmission from the access point (AP1, AP2) to the terminal (MT1–MT4), at least the following steps are taken:

— an encoding step for encoding the signal to be transmitted,

— a weighting step, in which at least two transmission signals are formed of the signal to be transmitted,

— a second conversion step, in which said at least two transmission signals are subjected to frequency-to-time conversion, and

— a transmission step, in which the transmission signals converted to the time domain are transmitted.

15. The method according to claim 13, **characterized** in that at least some of said steps are taken substantially simultaneously for signals relating to different terminals (MT1–MT4).

16 The method according to claim 13, **characterized** in that at least some of said steps are taken consequtively for signals relating to different terminals (MT1–MT4).

17. The method according to claim 1, **characterized** in that in the method, the access point (AP1, AP2) uses an array of several antennas (ANT1, ANT2, ANTn) and having a variable directional pattern.

19. The method according to claim 17, **characterized** in that information about the measured timing and frequency offsets as well as the spatial signature of the terminal (MT1–MT4) is stored at the access point (AP1, AP2), and that this information is used at least in the next data frame during the time slots (702–707, 802–807) addressed to said terminal (MT1–MT4), to modify the directional pattern of the array of antennas and to perform time and frequency corrections.

20. The method according to claim 17, **characterized** in that the timing and frequency offsets of the terminal (MT1–MT4) are measured with at least two different antennas (ANT1, ANT2, ANTn), and that an average is formed of the timing and frequency offsets measured with the different antennas (ANT1, ANT2, ANTn).

21. The method according to claim 17, **characterized** in that at least said second conversion step is taken substantially simultaneously for signals relating to different antennas (ANT1, ANT2, ANTn)

22. The method according to claim 17, **characterized** in that at least said second conversion step is taken consecutively for signals relating to different antennas (ANT1, ANT2, ANTn).

23. The method according to claim 17, **characterized** in that in the method, for the remainder signal

$$r_n[k,p] = x_n[k,p] - H_n[k] \times d[k]$$

a position correlation matrix is determined

$$Q[k,p] = \bar{r}[k,p] \times \bar{r}[k,p]^H$$

in which $x_n[k,p]$ is the n^{th} signal received from the antenna (ANT1, ANT2, ANTn) in the frequency domain at a subcarrier frequency corresponding to the p^{th} teaching symbol transmitted by the terminal in a training sequence, $d[k]$ is the training symbol at a subcarrier k, $H_n[k] = \left(\frac{1}{2}\sum_{p=1}^{2} x_n[k,p]\right) \times d[k]^*$ is one possible estimate for the frequency-domain radio channel calculated for the subcarrier k between the terminal and the antenna (ANT1, ANT2, ANTn) of the array of antennas of the base station,

$$\bar{r}[k,p] = (r_0[k,p], r_1[k,p], r_2[k,p], \ldots\ r_{N-1}[k,p])^T$$

the superscript H refers to complex conjugate transposition, the superscript * refers to complex conjugate, and the superscript T refers to transposition.

24. The method according to claim 17, **characterized** in that said measurements are taken during several time slots to improve the accuracy of timing, frequency offset and channel estimates as well as to estimate time stability of the timing offset, frequency offset and channel properties, wherein the stability estimates are used to select the terminals (MT1–MT4) which are allocated simultaneous time slots (702–707, 802–807).

27 The method according to claim 1, **characterized** in that in the method, spatial filtering is performed in the time domain before estimation and correction of the timing and frequency offsets of the terminal (MT1–MT4), wherein the spatial signature of the terminal (MT1–MT4) is estimated on the basis time-domain signals corresponding to the different antenna elements, that the spatial signature is stored to

be used in transmission and reception, and that the time and frequency offsets in the space filtered signal are estimated and corrected, and that the corrected signal is subjected to at least a conversion step to perform time-to-frequency conversion, a channel estimation step to perform and correct channel estimation, and a decoding step to decode the corrected signal to find out the information transmitted from the terminal (MT1–MT4).

30. The method according to claim 27, **characterized** in that the access point receives substantially simultaneously signals transmitted by at least two different terminals, wherein said spatial signatures stored in the memory are used in spatial filtering, and that said combination step, first correction step, first conversion step, first channel estimation step, and decoding step are separately performed for the signal of each terminal.

31 The method according to claim 27, **characterized** in that in data transmission from the access point to the terminal, the weighting of signals to be led to the antennas (ANT1, ANT2, ANTn) is performed at the access point (AP1, AP2) after the second conversion step in the time domain

32 The method according to claim 1, **characterized** in that the position of time slots to be used for estimation of terminals (MT1–MT4) to be served simultaneously is selected to be substantially the same as the position of simultaneous uplink and downlink time slots to be allocated to these terminals (MT1–MT4) later on in the data frame (FR)

33. The method according to claim 1, **characterized** in that the data transmission capacity is maximized by minimizing the time used by the access point for serving only one terminal at a time.

35. The method according to claim 1, in which the terminals transmit information in packets, **characterized** in that the lengths of the packets transmitted by the terminals to be served simultaneously are set to be substantially equal.

40. The access point (AP1, AP2) according to claim 38, **characterized** in that the access point (AP1, AP2) comprises an array of several antennas (ANT1, ANT2, ANTn) and having a variable directional pattern.

42. The access point (AP1, AP2) according to claim 40, **characterized** in that it comprises means (14) for storing information on the timing and frequency offsets of the terminal (MT1–MT4), and means (19, ANT1, ANT2, ANTn) for changing the directional pattern of the antenna in at least the next data frame for the time of time slots (702–707, 802–807) addressed to said terminal (MT1–MT4) on the basis of the spatial signature of said terminal (MT1–MT4).

43. The access point (AP1, AP2) according to claim 40, **characterized** in that it comprises means (ANT1, ANT2, ANTn, RX) for measuring the timing and frequency offsets of the terminal (MT1–MT4) with at least two different antennas, and means (19) for forming an average of the timing and frequency offsets measured with the different antennas.

44. The access point (AP1, AP2) according to claim 40, **characterized** in that the means (ANT1, ANT2, ANTn, RX) for measuring the timing and frequency offsets of the terminal (MT1–MT4) comprise at least:

— receiving means (RF1, RF2, RFn) for receiving signals transmitted by the terminal with at least two different antennas,

— correction means (E1, E2, En) for correcting the received signals on the basis of the measured time and frequency offsets,

— first conversion means (FFT1, FFT2, FFTn) for performing a time-to-frequency conversion on the corrected signals,

— channel estimation means (w1, w2, wn) for performing channel estimation on the signals converted to the frequency domain,

— combining means (C) for combining the filtered signals, and

— decoding means (DEC) for decoding the combined signal to determine the information transmitted from the terminal (MT1–MT4).

46. The access point according to claim 44, **characterized** in that it comprises means for receiving signals transmitted by two different terminals substantially simultaneously, wherein the access point (AP1, AP2) comprises said correction means, first conversion means (FFT1, FFT2, FFTn), combining means (C) and decoding means (DEC) for processing the signal of each terminal separately.

47. The access point (AP1, AP2) according to claim 40, **characterized** in that in data transmission from the access point (AP1, AP2) to the terminal (MT1–MT4), at least the following steps are taken:

— encoding means (M) for encoding the signal to be transmitted,

— weighting means (W) for forming at least two transmission signals from the signal to be transmitted,

— second conversion means (IFFT1, IFFT2, IFFTn) for performing a frequency-to-time conversion on said at least two transmission signals, and

— transmission means (RF1, RF2, RFn) for transmitting the transmission signals converted to the time domain

REMARKS

In accordance with 37 C.F.R. §1.121 (as amended on 11/7/2000) the rewritten claim(s) above are shown on separate page(s) marked up to show all the changes relative to the previous version of that section.

Respectfully submitted,

11 May 01

Date

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Application entitled: A METHOD FOR ARRANGING COMMUNICATION BETWEEN TERMINALS AND AN ACCESS POINT IN A COMMUNICATION SYSTEM

MARKED UP CLAIM(S)

3. The method according to claim 1 ~~or 2~~, **characterized** in that in the data transmission frames (FR), also a random access phase (RA) is used, during which the terminal (MT1–MT4) can perform transmissions to the access point (AP1, AP2), that signals transmitted in said random access phase (RA) are stored at the access point, and that the stored signals are used to determine the spatial signature of the terminal (MT1–MT4).

4. The method according to claim 1~~, 2 or 3,~~ **characterized** in that the stored signals are used to determine time and frequency offsets of the terminal (MT1–MT4).

5. The method according to ~~any of the~~ claims 1 ~~to 4~~, **characterized** in that said measurements are used to determine the position of the terminal (MT1–MT4).

6. The method according to ~~any of the~~ claim~~s~~ 1 ~~to 5~~, **characterized** in that in data transmission from the terminal (MT1–MT4) to the access point (AP1, AP2), at least the following steps are taken:

— a receiving step, in which signals transmitted by a terminal are received with at least two different antennas,

— a first correction step, in which the received signals are corrected on the basis of the measured time and frequency offsets,

— a first conversion step, in which the corrected signals are subjected to time-to-frequency conversion,

— a first channel estimation step, in which the signals converted to the frequency domain are subjected to channel estimation and determination of the spatial signature,

— a combination step, in which the signals are combined, and

— a decoding step for decoding the combined signal to determine the information transmitted from the terminal (MT1–MT4).

8 The method according to claim 6~~-or-7~~, **characterized** in that at least said first conversion step is taken substantially simultaneously for signals relating to different terminals.

9. The method according to claim 6~~-or-8~~, **characterized** in that at least said first conversion step is taken consecutively for signals relating to different terminals.

10 The method according to ~~any-of-the-~~claims 6~~-to-9~~, **characterized** in that after the combination step, also a second channel estimation and correction step is taken, in which properties of the communication channel are estimated on the basis of the combined signal, and the combined signal is corrected on the basis of the estimated properties of the communication channel.

11 The method according to ~~any of the~~ claims 6~~-to-10~~, **characterized** in that said combination step is taken after said second channel estimation and correction step

12. The method according to ~~any-of-the-~~claims 6~~-to-11~~, **characterized** in that signals transmitted by at least two different terminals are received at the access point substantially simultaneously, wherein said first correction step, first conversion step, combination step and decoding step are taken separately for the signal of each terminal

13. The method according to ~~any of the~~ claims 6~~ to 12~~, **characterized** in that in data transmission from the access point (AP1, AP2) to the terminal (MT1–MT4), at least the following steps are taken:

— an encoding step for encoding the signal to be transmitted,

— a weighting step, in which at least two transmission signals are formed of the signal to be transmitted,

— a second conversion step, in which said at least two transmission signals are subjected to frequency-to-time conversion, and

— a transmission step, in which the transmission signals converted to the time domain are transmitted.

15. The method according to claim 13~~ or 14~~, **characterized** in that at least some of said steps are taken substantially simultaneously for signals relating to different terminals (MT1–MT4)

16. The method according to claim 13~~ or 14~~, **characterized** in that at least some of said steps are taken consequtively for signals relating to different terminals (MT1–MT4).

17 The method according to ~~any of the~~ claims 1~~ to 16~~, **characterized** in that in the method, the access point (AP1, AP2) uses an array of several antennas (ANT1, ANT2, ANTn) and having a variable directional pattern.

19 The method according to claim 17 ~~or 18~~, **characterized** in that information about the measured timing and frequency offsets as well as the spatial signature of the terminal (MT1–MT4) is stored at the access point (AP1, AP2), and that this information is used at least in the next data frame during the time slots (702–707, 802–807) addressed to said terminal (MT1–MT4), to modify the directional pattern of the array of antennas and to perform time and frequency corrections.

20. The method according to claim 17, ~~18 or 19,~~ **characterized** in that the timing and frequency offsets of the terminal (MT1–MT4) are measured with at least two different antennas (ANT1, ANT2, ANTn), and that an average is formed of the timing and frequency offsets measured with the different antennas (ANT1, ANT2, ANTn).

21. The method according to any ~~of the~~ claims 17 ~~to~~ 20, **characterized** in that at least said second conversion step is taken substantially simultaneously for signals relating to different antennas (ANT1, ANT2, ANTn).

22. The method according to ~~any of the~~ claims 17 ~~to~~ 20, **characterized** in that at least said second conversion step is taken consecutively for signals relating to different antennas (ANT1, ANT2, ANTn).

23 The method according to ~~any of the~~ claims 17 ~~to~~ 22, **characterized** in that in the method, for the remainder signal

$$r_n[k,p] = x_n[k,p] - H_n[k] \times d[k]$$

a position correlation matrix is determined

$$Q[k,p] = \bar{r}[k,p] \times \bar{r}[k,p]^H$$

in which $x_n[k,p]$ is the n^{th} signal received from the antenna (ANT1, ANT2, ANTn) in the frequency domain at a subcarrier frequency corresponding to the p^{th} teaching symbol transmitted by the terminal in a training sequence, $d[k]$ is the training symbol at a subcarrier k, $H_n[k] = \left(\frac{1}{2}\sum_{p=1}^{2} x_n[k,p]\right) \times d[k]^*$ is one possible estimate for the frequency-domain radio channel calculated for the subcarrier k between the terminal and the antenna (ANT1, ANT2, ANTn) of the array of antennas of the base station,

$$\bar{r}[k,p] = (r_0[k,p], r_1[k,p], r_2[k,p], \ldots r_{N-1}[k,p])^T$$

the superscript H refers to complex conjugate transposition, the superscript * refers to complex conjugate, and the superscript T refers to transposition.

24. The method according to any of the claims 17 to 23, **characterized** in that said measurements are taken during several time slots to improve the accuracy of timing, frequency offset and channel estimates as well as to estimate time stability of the timing offset, frequency offset and channel properties, wherein the stability estimates are used to select the terminals (MT1–MT4) which are allocated simultaneous time slots (702–707, 802–807)

27 The method according to any of the claims 1 to 26, **characterized** in that in the method, spatial filtering is performed in the time domain before estimation and correction of the timing and frequency offsets of the terminal (MT1–MT4), wherein the spatial signature of the terminal (MT1–MT4) is estimated on the basis time-domain signals corresponding to the different antenna elements, that the spatial signature is stored to be used in transmission and reception, and that the time and frequency offsets in the space filtered signal are estimated and corrected, and that the corrected signal is subjected to at least a conversion step to perform time-to-frequency conversion, a channel estimation step to perform and correct channel estimation, and a decoding step to decode the corrected signal to find out the information transmitted from the terminal (MT1–MT4)

30. The method according to claim 27, 28 or 29, **characterized** in that the access point receives substantially simultaneously signals transmitted by at least two different terminals, wherein said spatial signatures stored in the memory are used in spatial filtering, and that said combination step, first correction step, first conversion step, first channel estimation step, and decoding step are separately performed for the signal of each terminal.

31 The method according to any of the claims 27 to 30, **characterized** in that in data transmission from the access point to the terminal, the weighting of signals to be

led to the antennas (ANT1, ANT2, ANTn) is performed at the access point (AP1, AP2) after the second conversion step in the time domain.

32. The method according to ~~any of the~~ claims 1 ~~to 31~~, **characterized** in that the position of time slots to be used for estimation of terminals (MT1–MT4) to be served simultaneously is selected to be substantially the same as the position of simultaneous uplink and downlink time slots to be allocated to these terminals (MT1–MT4) later on in the data frame (FR).

33. The method according to ~~any of the~~ claims 1 ~~to 32~~, **characterized** in that the data transmission capacity is maximized by minimizing the time used by the access point for serving only one terminal at a time

35 The method according to any of the claims 1 to 34, in which the terminals transmit information in packets, **characterized** in that the lengths of the packets transmitted by the terminals to be served simultaneously are set to be substantially equal.

40. The access point (AP1, AP2) according to claim 38 ~~or~~ 39, **characterized** in that the access point (AP1, AP2) comprises an array of several antennas (ANT1, ANT2, ANTn) and having a variable directional pattern

42. The access point (AP1, AP2) according to claim 40 ~~or 41~~, **characterized** in that it comprises means (14) for storing information on the timing and frequency offsets of the terminal (MT1–MT4), and means (19, ANT1, ANT2, ANTn) for changing the directional pattern of the antenna in at least the next data frame for the time of time slots (702–707, 802–807) addressed to said terminal (MT1–MT4) on the basis of the spatial signature of said terminal (MT1–MT4).

43. The access point (AP1, AP2) according to claim 40, ~~41 or~~ 42~~,~~ **characterized** in that it comprises means (ANT1, ANT2, ANTn, RX) for measuring the timing and frequency offsets of the terminal (MT1–MT4) with at least two different antennas,

and means (19) for forming an average of the timing and frequency offsets measured with the different antennas.

44. The access point (AP1, AP2) according to ~~any of the~~ claims 40 ~~to 43~~, **characterized** in that the means (ANT1, ANT2, ANTn, RX) for measuring the timing and frequency offsets of the terminal (MT1–MT4) comprise at least:

— receiving means (RF1, RF2, RFn) for receiving signals transmitted by the terminal with at least two different antennas,

— correction means (E1, E2, En) for correcting the received signals on the basis of the measured time and frequency offsets,

— first conversion means (FFT1, FFT2, FFTn) for performing a time-to-frequency conversion on the corrected signals,

— channel estimation means (w1, w2, wn) for performing channel estimation on the signals converted to the frequency domain,

— combining means (C) for combining the filtered signals, and

— decoding means (DEC) for decoding the combined signal to determine the information transmitted from the terminal (MT1–MT4).

46. The access point according to claim 44 ~~or 45~~, **characterized** in that it comprises means for receiving signals transmitted by two different terminals substantially simultaneously, wherein the access point (AP1, AP2) comprises said correction means, first conversion means (FFT1, FFT2, FFTn), combining means (C) and decoding means (DEC) for processing the signal of each terminal separately.

47 The access point (AP1, AP2) according to ~~any of the~~ claims 40 ~~to 46~~, **characterized** in that in data transmission from the access point (AP1, AP2) to the terminal (MT1–MT4), at least the following steps are taken.

— encoding means (M) for encoding the signal to be transmitted,

— weighting means (W) for forming at least two transmission signals from the signal to be transmitted,

— second conversion means (IFFT1, IFFT2, IFFTn) for performing a frequency-to-time conversion on said at least two transmission signals, and

— transmission means (RF1, RF2, RFn) for transmitting the transmission signals converted to the time domain.